METHOD FOR THE MANUFACTURE OF A BALL VALVE BETWEEN TWO TUBES

The object of the invention is a method for the manufacture of a ball valve between two tubes, in which method the ends of the tubes are sealed against a rotatable valve ball opening and closing the valve, and the valve ball and the ends of the tubes are surrounded by a sleeve-like cover to be seamed to the mantle surfaces of the tubes.

Ball valves are available in the markets provided with a full aperture, in which valve type the size of the ports of the valve ball approximately corresponds to the cross-section of the tubes sealed against the ball so that the valve does not substantially narrow the flow path formed by the tubes. In addition to these, ball valves with a reduced aperture are available in the markets, in which valves the ports are smaller than the cross-section of the flow path formed by the tubes. The operating principle of both the valve types is the same; the valve ball can be rotated around the axis perpendicular to the direction of the tubes with the help of a spindle connected to it so that the valve is open as the ports of the ball are turned towards the tubes and closed as the closed flanks of the ball are turned towards the tubes.

The last step in assembling the ball valve is to attach the sleeve-like cover, which is also called the valve body, surrounding the valve ball and the tube ends to the flanks of the tube by welding. The spatters that are generated in the welding can then become a danger to the valve ball fitted to the interior of the cover and to the gaskets for the tube ends against the ball. Upon rotating the valve ball, the attached spatters can damage the gaskets.

The patent specification US 5, 890,286 of the applicant discloses the manufacture of a ball valve with a full aperture, in which the tube ends coming against the valve ball are provided

with a stepped projection, which forms the gasket housing for the gaskets for the tube ends without narrowing the flow path. As the welding joints attaching the valve body to the tube flanks remain behind the stepwise protruding ends of the tubes, seen from the direction of the valve ball, the projections act as spatter shields, preventing the welding spatters from getting to damage the valve ball and the gaskets. However, despite its advantages, the solution described in the specification does not provide a full protection against spatters. Further, the solution would be very difficult to apply to ball valves with reduced openings, if at all, and the specification does not contain such a description.

The welding technique that is at present most often applied to the assembling of ball valves is the MIG welding performed by using a welding wire and inert shielding gas. In welding, the metal melts at the seam, and the welding wire melts as a part of the generated welding bead. Wire welding is strongly heat-generating, and besides the welding spatters already mentioned, also heating will be a danger to the gaskets for the tube ends. Deformations caused by heat and the irregular quality of the welding seam, in other words, the difficulties to achieve a seam of uniform quality and without root defects, lead to strength problems and to the exposure of the welding seams to corrosion.

Once central application of the ball valve are heating tubes, in which the valves have to endure stresses caused by the large variation of temperature. The regulations by authorities that are becoming more stringent, such as the application of the pressure vessel direction of the EU to valves, is leading to that it is no longer possible to meet the requirements of the most demanding categories with the ball valves manufactured using the state-of-the-art methods.

The object of the present invention is to provide a solution, which eliminates the above-mentioned quality problems of the present ball valves and makes possible the manufacture of

ball valves meeting the pressure vessel regulations in all respects. In addition, the invention relates to a manufacturing technique, which can be applied to the manufacture of ball valves with both full and reduced apertures. It is characteristic of the method of the invention for the manufacture of a ball valve between tubes that the mantle of the tube has a front face formed by a beveling or stepping, narrowing it towards the end of the tube, that the sleeve-like cover to be sealed to the mantle surfaces of the tube has an end face directed similarly to the front face of the tube, that the front face of the tube and the end face of the cover are brought against each other, and that the tube and the cover are jointed to each other by beam welding by directing the welding beam between said faces brought against each other, following their direction.

Thus, the solution of the invention comprises the machining of the faces of the tube and cover to be jointed to each other so that they will fit tightly to each other, in which case the jointing can be performed by beam welding, such as laser or electron beam welding, which is characterized in that no additional material is brought to the point of jointing for achieving the welding joint. The jointing is exclusively based on the welding beam having a melting effect on the faces to be jointed to each other.

Advantages of the beam welding are that the welding performance is fast and that substantially lower heat has to be brought to the structure to be welded. Thus, a welding joint of uniform quality without root detects is achieved, the strength of which is better and which meets the requirements relating to pressure vessels. As also the risk of spatters is small in beam welding, the welding joints can be brought nearer to the tube ends and the valve ball without causing risks to the gaskets. This again means that the cover surrounding the valve ball and the tube ends becomes even shorter, due to which material is saved and the structure can be made more rigid than before. A modular manufacturing technique can advantageously be used in the

manufacture, within which it is possible to achieve a wide product range with simple means of variation.

For the beam welding it is especially advantageous if the tube mantle contains turns or bends on both sides of the front face so that after penetrating the point of jointing formed by the opposite faces, the welding beam hits the material of the tube mantle, to which it stops. The welding beam is then absorbed to the tube mantle so that the possibility of the spatters to spread along with the beam to the internal space of the cover is fully eliminated. The front face required by the solution can be advantageously provided with a step to be made to the tube mantle beveled or perpendicular in relation to the axial direction.

The alignment of the welding beam is easiest, if the beveled front face of the tube mantle is in an angle of approximately 30-60°, preferably in an angle of 45° in relation to the axial direction of the tube. The laser radiator or some other radiation source can then be kept at a suitable distance from both the tube mantle and the spindle sleeve to be perpendicularly attached to the sleeve-like cover. The welding beam being in the said angles, tubes made of materials of different thickness can be connected to a similar valve cover, and the same welding parameters can thus be used for different tubes.

According to the invention, also the said spindle with the surrounding sleeve rotating the valve ball can be installed in the valve using beam welding for the jointing of the sleeve. An aperture has to be formed to the sleeve-like cover of the valve for the spindle and the sleeve surrounding it so that the edge of the aperture can be formed so that it is located in one plane parallel to the axis of the tubes. As the spindle with the surrounding sleeve is fitted into the aperture, the welding joint can be made in one plane in the beam welding in a way required by the quality requirements for beam welding. Also the mating faces of the edge of the aperture and

the spindle sleeve to be jointed together can be in an angle of 30-60°, preferably in an angle of 45° in relation to the axial direction of the tubes so that neither the spindle sleeve nor the tubes form an obstacle for the welding. If the said mating faces and the above-mentioned front face of the tube mantle are in the same angle in relation to the axial direction of the tubes, it is possible to perform the jointing of the cover to the tube mantle and the jointing of the sleeve surrounding the spindle to the cover successively without it being necessary to change the alignment of the source of the welding beam.

In addition to the method for the manufacture of the ball valve disclosed above, the present invention comprises the use of beam welding, such as laser or electron beam welding for assembling the ball valve, for fastening the sleeve-like cover surrounding the valve ball and the tube ends sealed against it from its ends to the tube flanks and/or for fastening the support sleeve of the spindle rotating the valve ball to the aperture made to the said sleeve-like cover.

The invention is next described in more detail with the help of examples, referring to the enclosed drawings, in which

Figure 1 is a longitudinal section of the cover blank;

Figure 2 is the cross-section II-II of the cover blank in Figure 1;

Figure 3 shows the forming of the cover blank to the sleeve-like cover of the ball valve with reciprocating moulding tools compressing the blank;

Figure 4 shows the sleeve-like cover of the ball valve formed by compression and the valve ball in longitudinal section;

Figure 5 is the cross-section V-V of the cover and valve ball in Figure 4;

Figure 6 shows the cover of the ball valve with its valve ball, the tubes to be connected to the valve ball, and the spindle rotating the valve ball with its support sleeves and handles before

joining the said parts together;

Figure 7 shows the parts in Figure 6 assembled as a ball valve, which is jointed by welding and provided with a reduced aperture, the Figure also depicting the sources of radiation and the welding beams directed from them to the welding joints;

Figure 8 shows a second embodiment of the ball valve with a full aperture, jointed by beam welding;

Figure 9 shows the cover and the tube mantle welded to it, the material thickness of which is substantially the same, in enlarged scale; and

Figure 10 is similar to Figure 9, showing an embodiment, in which the material thickness of the cover is larger than that of the tube mantle.

The ready-assembled ball valve 1 with a reduced aperture shown in Figure 7 is described first. The ball valve 1 comprises the valve ball 2, which works as the joint body between two tubes 3, 4 with round cross-section, connected to the valve. The valve ball 2 is hollow, and it comprises ports 5, 6, which are slightly reduced in relation to the tubes and which in the Figure are turned towards the tube ends 7, 8 so that the flow channel 9 formed by the tubes 3, 4 is open. The element that keeps the ball valve 1 together consists of the sleeve-like cover 10 tapered from both ends by compression, i.e. the so-called valve body, the ends of which are attached to the flanks of the tubes 3, 4 with the welding joints 11, 12. For opening and closing the ball valve 1, the spindle 13 is fastened to the valve ball 2, the spindle being surrounded by the support sleeve 14 and provided with the handle 15. The support sleeve 14 is fitted to the aperture made for it in the cover 10 and attached to it by the welding joint 16. Closing the valve is performed by rotating the spindle 13 and the valve ball 2 rotating with it 90° from the position in the Figure, using the handle 15 so that the closed flanks of the valve ball rotate against the ends 7, 8 of the

tubes 3, 4. The ends 7, 8 of the tubes are provided with the gaskets 17 against the ball valve 2 for preventing leakage.

The steps according to the invention for the manufacture and assembly of the ball valve 1 with a reduced aperture appear from the Figures 1-7 in the drawings. The starting point is the cover blank 18 according to Figures 1 and 2, formed of the tube piece, the round seat 19 in the plane parallel to the longitudinal axis of the piece being machined to the cover blank for the subsequent fastening of the spindle 13 and its support sleeve 14. For the support sleeve 14 of the spindle, the aperture 20 is pierced at the place of the seat 19; the aperture can be seen in Figures 3-6 in the sleeve-like cover 10 of the valve, machined from the blank 18. The machining also comprises the beveling of the edge 21 of the aperture 20 and the ends 22, 23 of the generated cover 10 for the subsequent jointing by beam welding. The conically beveled end faces 22, 23 of the cover form an angle of 45° in relation to the axial direction of the tubes 3, 4.

The forming of the cover blank 18 according to Figures 1 and 2 to the sleeve-like cover 10 tapering conically towards its ends 22, 23 by compressing is performed by reciprocally moving moulding tools 24, according to Figure 3. The tools 24 are forced towards each other according to the arrows in Figure 3 until they bump into each other, after which the tools perform the return movement. Before compression the valve ball 2 has been brought to the interior of the cover blank 18, support to appropriate termporary support elements (not shown). The valve cover 10 machined to its finished form as the result of compression is shown in Figures 4 and 5.

Figure 6 is a schematic presentation of the parts of the ball valve during the jointing step. The end of the spindle 13 is attached to the hole 25 provided for it in the valve ball 2 so that the end face 26 of the support sleeve 14 of the spindle, beveled similarly to the edge 21 of the aperture of the cover, is set to lean against the said edge. From the ends 22, 23 of the cover, the

tubes 3, 4 are brought to the interior of the cover so that the ends 7, 8 of the tubes are sealed against the valve ball 2. The flanks of both the tubes 3, 4 have the front face 29 rotating conically around the tube and being restricted by the folds 27, 28, the front face being machined in the angle of 45° in relation to the axial direction of the tube, similar to the end faces 22, 23 of the cover. As the tubes 3, 4 have been brought to place, the front faces 29 are set tightly against the end faces 22, 23 of the cover to be jointed by beam welding the tubes and the cover.

The said bringing together of the valve parts brings them to a position in relation to each other, in which they are in the finished ball valve 1 according to Figure 7. The jointing together of the parts is performed by beam welding, and Figure 7 shows the source of radiation 30 and the welding beam 31, for example, laser beam generated by it in three different positions 30a-30c required by the welding of the joints 11, 12, 16. The inlet angle α of the welding beam 31 marked to the Figure is equal to the angle of 45° of the surfaces to be welded in relation to the axial direction of the tubes. The welds can be performed either by rotating the source of raditation 30 in relation to the strationary valve or keeping the source of radiation stationary and rotating the valve. It can be seen from Figure 7 that in the welding of the front faces 3, 4 of the tubes and the ends of the cover 10 in the welding beam 13 penetrating the joint 11, 12 meets the material of the tube mantle, to which the travel of the beam stops.

Figure 8 shows the finished beam-welded ball valve 1 with full aperture, which differs from the one shown in Figure 7 in that the ports 5, 6 of the valve ball 2 generally correspond to the cross-sectional area of the tubes 3, 4 so that, because of this, the flow channel 9 formed by the tubes penetrates the valve without choking. In both the tubes 3, 4 the mating comprises the expansion 32, which is conical seen from the direction of the tube and for which the cover 10 tapering towards its ends forms a direct continuation. The expansion 32 is followed by

successive turns 27, 28, restricting between them the front face 29, which conically reduces the tube mantle, the end of the cover being attached to the front face by beam welding as in the form of embodiment described above, cf. Figures 6 and 7.

Figures 9 and 10 are intended to illustrate the possibility offered by the invention to use cover parts 10 with similar material thickness in connection with tubes 4 with different material thickness. In Figure 9, the material thickness of the cover 10 and the mantle of the tube 4 is essentially the same, when again in Figure 10, the cover 10, which is the same as in Figure 9, has a bigger material thickness than the mantle of the tube 4. The front face 29 restricted by the turns 27, 28 has similar dimensions in each case, and the beam welding by the welding beam 31 directed according to the surface can in both cases be performed using the same welding parameters.

It is obvious for one skilled in the art that the embodiments of the invention are not restricted to the examples described in detail above, but they may vary within the scope of the following claims.